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VERIFICATION OF A TRANSLATION

I, Henry M. Feiereisen, having a place of business at 350 Fifth Avenue, Suite 3220, New York, N.Y. 10118, depose and state that:

1. I am familiar with the English and German languages.
2. I have read the attached German language International PCT patent application PCT/EP99/01398, filed on March 4, 1999.
3. The hereto attached English language text is an accurate translation thereof.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.



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Date: September 5, 2000

EXTRUSION HEAD

Background of The Invention

The invention relates to an extrusion head for producing a tubular parison for the manufacture of blow-molded plastic hollow bodies, including an adjustable ring-shaped tube outlet nozzle with annular nozzle/mandrel gap adjustment elements which permit a targeted adjustment of the nozzle gap for varying the wall thickness of the exiting parison.

Typical examples of such blow-molded parts of thermoplastics, in which customarily a targeted wall thickness adjustment is carried out in longitudinal direction of the tube and in circumferential direction of the tube, include large-volume containers such as, for example, canisters, lidded drums, bung drums or inner receptacles for pallet containers. During ejection of the tubular parison used for such blow-molded parts, the wall thickness of the tube is so adjusted by a rotation-symmetrical nozzle/mandrel gap control mechanism in longitudinal direction of the tube that the wall is slightly thinner toward the lower end and slightly thicker toward the upper end in direction of the discharge valve, because the tube as a consequence of its own weight lengthens by itself when suspended to thereby automatically realize an even axial wall thickness. Superimposed thereto is a partial wall thickness control in circumferential direction which is realized by a double nozzle/mandrel gap control mechanism in the tube in those tube zones which are provided in the blow-molded hollow body for the head and

bottom areas at greatly varying degrees of elongation - particularly in the areas which are offset by 90° to the partition plane of the blow mold halves.

With double nozzle/mandrel gap control mechanisms (= two control choices) known heretofore, the wall thickness of such blow molded parts can be controlled over their length with respect to:

- uniform radial wall thickness
- radial and circumferential wall thickness
- radial wall thickness with axially extending thick and thin areas, and
- partial longitudinal thick/thin areas.

Various constructions of extrusion heads are known for such tube adjustments by means of nozzle/mandrel gap control, for example from German Pat. No. 26 54 001, U.S. Pat. No. 3,114,932 or U.S. Pat. No. 1,107,628. Although for standard applications, simple conventional or the double nozzle control mechanisms suffice, they lack the capacity to carry out additional influences of the wall thickness. A simple extrusion head is further disclosed in British patent specification 1,107,628 for producing teeth or ribs in the extruded tube for bottles blow-molded from thermoplastic material. By means of V-shaped grooves and teeth formed in the ejector die, the blown bottles should receive in particular a decorative look. The central mandrel can be adjusted axially so that the ejected tube may or may not be acted upon by the teeth. A further adjusting option or

1 possible influence to permit a targeted wall thickness adjustment is, however, not
2 possible.

Summary of The Invention

4 It is an object of the present invention to obviate the mentioned drawbacks
5 of the prior art and to improve the extrusion head of the type as described above
6 with a double nozzle/mandrel gap control so as to permit a further additional
7 superimposed wall thickness adjustment of the ejected tube for large-volume
8 plastic containers such as 220 liters drums and - particularly also for asymmetric
9 technical parts such as e.g. plastic fuel tanks (KKB) or for special applications in
10 large cylindrical blow molded parts.

12 This object is attained in accordance with the invention by providing at
13 least three separate nozzle/mandrel gap adjustment elements (D 0 = mandrel,
14 DS I, DS II, DS III) which are separately controlled, differently profiled, and
15 adjustable, and which individually or/and simultaneously can be brought into
16 active engagement in the nozzle gap with the exiting parison from inside and
17 outside.

19 Since the tube outlet nozzle is equipped with a triple nozzle/mandrel gap
20 control mechanism, special thick areas can be so adjusted at particular locations
21 of the tube depending on the blow molded hollow body in dependence on the
22 configuration of the third nozzle/mandrel gap adjustment element, or further
23 adjustment elements and on the duration of the intervention or impact on the

1 extruded parison, that the final blow molded hollow body exhibits only in the
2 desired wall regions different or thicker wall thickness in comparison to the
3 minimum wall strength of the typical wall.

4
5 A canister can, for example, be provided with stiffening ribs only at the
6 vertical corner areas. In a KKB, the walls can also be made specifically thicker
7 and thus more stable, e.g. in the side areas of the top bottom or at those areas at
8 which connection stubs of fuel pipes are blow-molded thereon, or measuring
9 instruments for a fuel tank level gauge are to be installed. In bung drums or
10 lidded drums, it is possible to adjust a ribbed wall construction with uniform thick-
11 thin distribution only in the vertical wall areas through a targeted material
12 redistribution while, for example, maintaining the existing drum weight, thereby
13 measurably improving the stiffness of the container, and in particular, the
14 stacking strength when charged with hot contents. This is especially of particular
15 importance in connection with large-volume drums (220 liters). Remarkably, the
16 steps for quality improvement of the blow-molded hollow plastic body are realized
17 exclusively on the exiting parison itself and not through constructive redesign of
18 the blow mold.

19
20 As shown by way of example only, the novel triple or multi-nozzle/mandrel
21 gap adjustment elements according to the novel invention results
22 advantageously in a variety of new possibilities of application for large-volume
23 blow-molded plastic parts of all types (e.g. automobile accessories or the like).

1 Compared to a conventional extrusion head with heretofore dual
2 nozzle/mandrel gap adjustment elements, the provision of an extrusion head with
3 the novel triple nozzle/mandrel gap adjustment elements according to the
4 invention can be realized comparably inexpensively and does not require any
5 investment in machines. The adjustment elements are moved only over very
6 short distances, and only simple control motors are sufficient, and no deformation
7 of the adjustment elements is experienced.

8
9 The process according to the invention for producing blow-molded hollow
10 plastic bodies by a blow mold machine with extruder, extrusion head with
11 circumferential distributor and respective blow mold, and carrying out a particular
12 adjustment of the wall thickness of the exiting parison during ejection of the
13 tubular parison from the extrusion head through adjustment of the
14 nozzle/mandrel gap, is characterized in particular by realizing a random,
15 circumferentially varying thick-thin adjustment of the tubular parison through a
16 sequential or simultaneous impact of three differently profiled, separately
17 adjustable nozzle/mandrel gap adjustment elements. This multiple adjusting
18 capability of the tube for large-volume drums is unique and results in a quality of
19 the drums that has been unattainable to date.

20 *Brief Description of the Drawings*

21 The invention will now be explained and described in more detail by way
22 of exemplified embodiments illustrated only schematically in the drawings, in
23 which:

FIG. 1 shows a partially sectional illustration of an extrusion head according to the invention;

FIGS. 2 to 6 show the extrusion head according to FIG. 1 with different operational positions of the adjustment elements;

FIGS. 7 to 9 show a modified embodiment of an extrusion head with different operational positions of the nozzle/mandrel gap adjustment elements;

FIG. 10 shows a further modified embodiment of an extrusion head;

FIG. 11 shows a fourth modified embodiment of an extrusion head;

FIGS. 12 to 15 show a fifth modified embodiment of an extrusion head with different operational positions of the nozzle/mandrel gap adjustment elements;

FIG. 16 shows a lidded drum as blow-molded hollow body;

1 and two adjustable nozzle/mandrel gap adjustment elements, namely the nozzle
2 slide 1 = DS I and the nozzle slide 2= DS II. Like the adjustable mandrel 14, also
3 the axially adjustable adjustment elements DS I and DS II are secured to the
4 extrusion housing for easy detachment and exchange. The axial adjustment and
5 exact positioning of the adjustable nozzle/mandrel gap adjustment elements may
6 be realized e.g. hydraulically or electromotorically. Furthermore, the housing-
7 fixed nozzle ring part DF is likewise secured to the extrusion head in a manner
8 that permits easy detachment and exchange.

9
10 This is of particular importance in order to realize during a product change
11 or replacement of the subsequent blow mold also a rapid exchange of the ring
12 parts and adjustment elements of the nozzle gap, which are suited to the product
13 at hand and accordingly profiled.

14
15 In the extrusion head 10 shown in FIG. 1, all nozzle/mandrel gap
16 adjustment elements are returned to their basic position "nozzle gap closed", i.e.
17 the mandrel D 0 has traveled to the uppermost position, and the nozzle slide =
18 adjustment elements DS I and DS II have traveled to the lowermost position. The
19 respective lengths of path = adjustability of the adjustment elements, are
20 indicated by the respective arrows. In the illustrated exemplified embodiment, the
21 nozzle gap defining surfaces of the fixed nozzle ring part DF and the adjustment
22 element DS I are profiled, and the nozzle gap defining surfaces of the

1 mandrel D 0 and of adjustment element DS II have smooth circumference, as
2 further described with reference to the following Figures.

3

4 In FIG. 2, only the mandrel 14 is slightly moved downwards (see arrow).
5 The nozzle gap 20 is demarcated at the outside by the lower inner
6 circumferentially smooth edge 24 of the nozzle slide DS II, and at the inside by
7 the mandrel 14. The discharged tube 22 is evenly thin about its circumference. In
8 the partial section of the tube 22, as illustrated therebelow, a small arrow
9 indicates the potential thickness of the tube when the mandrel travels to the
10 lowermost position and the nozzle gap is fully open.

11

12 In FIG. 3, the adjustment element DS I together with the adjustment
13 element DS II is slightly moved upwards (see arrow), so that these two
14 adjustment elements are not in operative engagement at that point with the
15 exiting tubular parison 22. The nozzle gap 20 is now demarcated by the
16 mandrel 14 and the profiled housing-fixed ring part DF. The tube exiting the
17 nozzle gap is no longer uniformly thick in circumferential direction, but is slightly
18 thinner in two opposing regions than the respective tube regions respectively
19 arranged offset by 90° thereto. Such a double-oval adjustment of the nozzle gap
20 or oval wall thickness adjustment in areas of the tube is typical for blow molded
21 parts with flat top plate and bottom plate, whereby, the two opposing tube
22 sections 26 with greater wall thickness are so guided between the open blow
23 mold halves that the horizontal container wall areas, which are offset by 90° to

1 the mold partition plane, are blow-molded therefrom with the greatest stretching
2 degrees and blow paths of the plastic material. This feature thus serves as a
3 measure to attain a uniform wall thickness in the finished container, so that the
4 container wall is not thinner in the corner areas with high degrees of stretching or
5 orientation in comparison to the remaining vertical wall parts. FIG. 3 illustrates a
6 sectional view through the thinner tube area (and extrusion head) which bears in
7 the blow mold in the mold partition plane upon the blow mold wall.

8
9 FIG. 4 shows the same position of the nozzle/mandrel gap adjustment
10 elements compared to FIG. 3, but at a 90° rotated section through the extrusion
11 head and thus through a thicker wall zone 26 of the tube 22, as clearly illustrated
12 by the partial sectional view through tube 22 therebelow. To the left, next to the
13 profiled ring part DF, there is indicated a developed view of the known wavy
14 profile of the inner nozzle surface of the ring part DF.

15
16 In FIG. 5 and FIG. 6, the profiled nozzle slide DS I is moved downwards
17 and acts on the exiting plastic tube, while the nozzle slide DS II still remains in its
18 previous upper position outside a zone of influence. The profile of DS I includes a
19 circumferential tooth profile, as clearly shown therebelow by the partial sectional
20 illustrations of the exiting tube 22. The teeth 30 of the profile form a thinner tube
21 wall thickness, and a greater tube wall thickness with outwardly projecting ribs is
22 formed in the tooth gaps 32. FIG. 5 shows the section through the extrusion head
23 and the tube 22 in the area of a thinner tube wall (tooth action 30), and FIG. 6

1 shows a slightly offset section in the area of a thicker tube wall (tooth gap
2 action 32), with pronounced formation of longitudinal ribs 28. The profile in the
3 fixed nozzle ring part DF, as well as in the nozzle slide DS may be expanded
4 slantingly outwardly or simply parallel to the surface of the mandrel 14. FIG. 6
5 indicates by way of the small arrow below the nozzle guide DS II, the depth by
6 which the teeth 30 of the tooth profile of the nozzle slide DS I are able to act on
7 the tube 22 from outside. To the left of the nozzle slide DS I is a schematic
8 illustration, in developed view, of the tooth profile of the DS I with teeth 30 and
9 tooth gaps 32. In this embodiment, the lowermost non-profiled nozzle slide DS II,
10 serves actually only as a smoothening element or to cover the profiles of the ring
11 part DF or/and to cover the nozzle slide DS I.

12
13 FIG. 7, FIG. 8 and FIG. 9 illustrate a modified embodiment of an extrusion
14 head according to the invention, with the special profile (= tooth profile) formed
15 on the nozzle slide DS II instead of on the nozzle slide DS I, while the nozzle
16 slide DS I has a smooth circumferential surface in direction of the nozzle gap. In
17 FIG. 7, both nozzle slides DS I and DS II are moved into their uppermost position
18 (outside of zone of influence), and only the oval- profile of the housing-fixed ring
19 part DF and the adjustable mandrel 14 act on the tube 22 in the nozzle gap 20.
20 The small partial sectional views on the side indicate on the left a thinner tube
21 wall thickness (in mold partition plane FT) and on the right a thicker tube wall
22 thickness (90° with respect to the mold partition plane FT). In FIG. 8, both nozzle
23 slides DS I and DS II are moved downwards. The DS I has a lower smooth

1 circumference and covers the oval-profile of the fixed ring part DF, thereby
2 rendering it ineffective. The tooth profile of the lower nozzle slide DS II acts in the
3 nozzle gap 20 on the exiting tube 22 and produces the profiled tube formation
4 with the longitudinal ribs 28, as illustrated in the small partial sectional illustration.

5
6 FIG. 9 shows a positioning of the adjustment elements in which no profile
7 is effective, but rather only a circumferentially even change of the wall thickness
8 can be carried out by an axial displacement of the mandrel 14. In accordance
9 with the wall thickness diagrams a, b, and c, which illustrate for each adjustment
10 element a separate control program, as shown in the lower left hand side of
11 FIG. 9, the control of adjustment elements D 0, DS I and DS II for adjusting a
12 desired wall thickness over the length L of the exiting tube is effected at the blow
13 form machine. Diagram a shows - as does the partial sectional view to the right
14 of the ejected tube 22- an even increase of the wall thickness from bottom to top,
15 by opening the nozzle gap 20 through axial displacement of mandrel 14 in
16 downward direction. The added wall thickness for the top plate and bottom plate
17 of the drum, as shown in diagram b, is realized by the oval profile in the fixed
18 nozzle ring part DF which is cleared when the non-profiled and smooth nozzle
19 slide DS I travels upward. At that point, the tooth profile nozzle slide DS I is
20 hereby not effective. For adjustment of the tooth profile in the tube - e.g. for
21 longitudinal ribs in the vertical wall region of the bung drum as shown to the right
22 thereof - the nozzle slide DS II is moved downwards for active engagement,
23 whereby also the nozzle slide DS I moves downwards, thereby covering again

the profile of the fixed ring part DF. In order to maintain an even thickness of the tube, the mandrel 14 is also moved simultaneously slightly downwards, and the nozzle gap opened as needed. For clarification, it should be noted that the nozzle slide with the novel tooth profile of the nozzle slide realizes in general only a redistribution of the plastic material in the nozzle gap, whereby the free cross sectional area of the nozzle gap may remain constant.

Another embodiment of an extrusion head according to the invention is shown in FIG. 10, whereby no profiled housing-fixed ring part is provided and the nozzle slide DS I is also not profiled but exhibits a circumferentially smooth inner surface towards the nozzle gap 20. The known oval profile is formed in the nozzle slide DS II, with an exchangeable mandrel 34 having a special configuration. At its outer circumference, the mandrel 34 is provided in direction of the nozzle gap 20 with a plurality of ribs 14*, which are evenly spaced from one another in a star-shaped manner, and interposed grooves. Disposed at the lower end of the mandrel head 34 is the axially adjustable adjustment element D 0* which is provided exteriorly with correspondingly formed ribs extending upwardly and uniformly spaced from each other for precisely filling in flush engagement the grooves and intermediate spaces between the ribs 14*. When the star-shaped slide = adjustment element D 0* occupies its uppermost basic position, the ribs of star-shaped slide D 0* extend in the nozzle gap 20 flush with the ribs 14* of the mandrel 34, so that the interlocking ribs of the mandrel head 34 form a smooth conical surface in the nozzle gap. In contrast thereto, when the

1 star-shaped slide D 0* travels downwards, the intermediate spaces between the
2 ribs and the grooves of the mandrel head 34 are cleared and the stationary ribs
3 14* act in the nozzle gap on the exiting tube 22, thereby forming a tooth profile in
4 the inner surface of the tube in dependence on the geometry of the ribs 14*. An
5 up and down movement of the smooth non-profiled nozzle slide DS I allows, in
6 general, an even adjustment of the wall thickness, while the oval profile of the
7 tube is effected by the respectively profiled nozzle slide DS II, whereby the
8 nozzle slide DS II travels into a lower position, with the minimum wall thickness of
9 the tube being adjusted by the nozzle slide DS I. Then, DS II remains in position,
10 and DS I travels slightly upwards, whereby the oval profile in DS II is cleared, and
11 the tube is formed with respectively thicker walls in the two diametrically
12 opposing zones. This construction of the extrusion head permits a best possible
13 superimposed action of the various adjustment elements upon the tube.

14
15 A further embodiment is shown in FIG. 11, illustrating a modification of the
16 extrusion head shown in FIG. 6, with a ring sleeve as nozzle slide DS III being
17 secured inside the nozzle head DS II for adjustment in circumferential direction.
18 This ring sleeve = DS III has at its bottom side a same tooth profile as the nozzle
19 slide DS I disposed on the inside. Additionally, the nozzle slide DS II is slightly
20 slanted inwardly at the bottom. When downwardly moving the nozzle slide II
21 together with ring sleeve DS III so as to be flush with the nozzle slide I, a rotation
22 of the ring sleeve enables a covering or opening of the teeth of the nozzle
23 slide DS I from the side. In this way, the formation of the rib width on the exiting

1 tube 22 can be continuously modified or randomly adjusted. A simultaneous up
2 and down movement of the nozzle slide DS II together with the ring sleeve DS II
3 also allows the height of the ribs 28 to be continuously modified and adjusted.
4

5 Finally, FIG. 12, FIG. 13, FIG. 14 and FIG. 15 show a further
6 advantageously configured extrusion head. The even wall thickness about the
7 circumference is adjusted with the adjustment elements D 0 = mandrel 14. A
8 profiled housing-fixed ring sleeve is not provided; however, if needed, may be
9 provided for installing a further special profile. The nozzle slide DS I has the tooth
10 profile and is provided with a greater stroke of its adjustment drive. Furthermore,
11 the nozzle slide DS II is provided with the oval profile and of split configuration
12 i.e. it is made in this case of two 180° half ring parts which are guided and
13 secured on the nozzle slide DS I for displacement in radial direction. In FIG. 12,
14 all adjustment elements have traveled into the basic position "nozzle slide
15 closed". In FIG. 13, the nozzle gap is opened, with mandrel 14 having traveled
16 downwards. Likewise, the nozzle slide DS I together with DS II have traveled
17 axially downwards, with the attached nozzle slide DS II acting with its oval profile
18 in the nozzle gap 20 on the exiting tube. In FIG. 14, both half ring parts of the
19 nozzle slide DS II have traveled radially outwards and are no longer in an active
20 engagement. As shown in FIG. 15, the nozzle slide DS I is now slightly moved
21 further downwards until its tooth profile or special profile is in active engagement.
22 The advantage of this construction is the need for only a single lifting drive for the
23 nozzle slides DS I and DS II. The short radial movement of the DS II - half rings

1 could be realized, for example, by an electric spindle motor or a respective small
2 drive. This configuration is suited e.g. particularly for retrofitting existing extrusion
3 heads.

4
5 The adjustment elements of all embodiments are basically attached to the
6 extrusion head in an easily exchangeable manner. The nozzle slide with the
7 tooth profile may certainly also be modified depending on the desired profile
8 requirement of the hollow body to be blow-molded (cf. FIGS. 19, 20).

9
10 FIG. 16 illustrates a 220 liter lidded drum 36 having longitudinal ribs which
11 are formed in the vertical wall zones and evenly spaced from one another but
12 which do not extend into the bottom region, as shown in the sketched partial
13 sectional illustration below with constant drum wall thickness.

14
15 Exemplified embodiment: A 220 l plastic drum (e.g. Vanguard lidded
16 drum) with a drum body weight of approximately 7.5 kg has a largest diameter in
17 the drum wall or foot ring of about 575 mm. The swelling parison exiting the
18 nozzle gap has a diameter of about 270 mm with a wall thickness of about 12 to
19 25 mm. By means of the adjustment elements, the wall thickness of the tube can
20 be adjusted partially or along sections in this thickness range or adjusted at even
21 greater range. Hereby, the particular adjustment element D 0* is advantageously
22 provided with a rectangular tooth profile, whereby the diameter of the adjustment
23 element D 0* amounts to about 190 mm, and the inner and outer ring edges,

1 interacting with the ejected tube, have alternately about 60 grooves which are
2 half-round as viewed in cross section, and a complementary number of
3 rectangular teeth, with the width of the grooves being about 4 mm and the width
4 of the teeth about 5 mm. The radial depth of the grooves is thereby about 10 mm.
5 The configuration of the rectangular teeth is hereby of importance; a toothed
6 engagement with pointed saw teeth is unsuitable for large-volume containers
7 according to the invention with a diameter of about 585 mm and a weight of
8 about 8 to 10 kg plastic material, because the extension of the thinner areas in
9 circumferential direction of the drum body must be wider in any case than the
10 thicker areas (= internal ribs) in the axial drum wall of the finished blow-molded
11 hollow body.

12
13 FIG. 17 shows a fassett 38 in which only the vertical wall zones are
14 reinforced by longitudinal ribs. This longitudinal ribbing is clearly illustrated in the
15 partial sectional illustration through the container wall.

16
17 FIG. 18 shows a canister 40 formed only in the corner regions with two
18 longitudinal ribs which extend, however, to the top plate and bottom plate, as
19 indicated in the partial sectional view below. A longitudinal and cross-sectional
20 view of a tubular parison 22 with special profile for a plastic fuel tank KKB 42 is
21 shown in FIG. 19, with FIG. 20 showing flash pieces still attached thereto.

- 1 The extrusion head according to the invention with three separate
- 2 adjustment systems is particularly suitable to fabricate and produce such special
- 3 profiles with partial material accumulation (cf. section B-B in FIG. 19) as required
- 4 for KKB 42 in the area of a stub opening (cf. section D-D in FIG. 20).

LIST OF REFERENCE NUMERALS

- 10 Extrusion head
- 12 Mandrel holder
- 14 Mandrel = D 0 (Dzero)
- 16 Extrusion head housing
- 18 Storage space
- 20 Nozzle gap
- 22 tubular parison
- 24 inner edge DS II
- 26 thicker tube zone
- 28 Ribs in 22
- 30 Tooth
- 32 Tooth gap
- 34 Mandrel head for 14*
- 36 Lidded drum (Vanguard FRH-drum)
- 38 Fasset®
- 40 Canister
- 42 Plastic fuel tank (KKB)

Nozzle/Mandrel Gap Adjustment Elements:

- DF fixed nozzle ring part
- D 0 first adjustment element = mandrel 14
- DS I second adjustment element = nozzle slide 1
- DS II third adjustment element = nozzle slide 2
- DS III fourth adjustment element = rotatable ring sleeve
- D 0* star-shaped adjustment element on mandrel 14